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Article *in* Annual Review of CyberTherapy and Telemedicine · January 2017

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Behavioral, craving, and anxiety responses among light and heavy drinking college students in alcohol-related virtual environments

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Abstract. Drinking-related behavior in college students represents a public concern with consequences for health and academic performance. The aim of the present study was to determine which measures (behavioral and self-reported measures of craving and anxiety) differentiate best between light- and heavy-drinking college students when exposed to a virtual reality (VR) alcohol-cue environment. 25 college students participated in this study, of whom 13 were light drinkers (standard drink units (SDU)/month ≤ 10) and 12 heavy drinkers (SDU)/month ≥ 11). Participants completed the Alcohol Use Disorder Identification Test (AUDIT) before exposure to the VR environment. Heavy drinkers scored higher than light drinkers on AUDIT. The virtual environment consisted of four situations: restaurant, bar, chill-out area, and bedroom, where participants could choose alcoholic or non-alcoholic beverages. An Oculus Rift DK2 headset was used as the HMD. In each situation, craving and anxiety were self-reported on a visual analog scale (VAS, from 0 to 10). The results showed differences between groups in the type of beverage chosen in the VR situations, whereby heavy drinkers chose alcoholic drinks more frequently. However, no statistically significant differences were found between groups in craving or anxiety levels reported on the VAS during VR exposure. Heavy-drinking students show a preference for alcoholic beverages in all VR situations compared with light drinkers, but do not experience different levels of craving or anxiety as assessed with VAS. If virtual environments are used to detect heavy drinking cases, behavioral parameters such as choosing between alcoholic or non-alcoholic cues seem more suitable than self-reports of craving or anxiety. Nevertheless, future studies are necessary to determine whether more objective measures of craving and anxiety (eye tracking or psychophysiological responses) perform better than self-reports in differentiating between heavy and light drinking.

Keywords: Virtual Reality, alcohol, craving, assessment

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1. Introduction

It has been extensively noted that excessive alcohol consumption has a serious impact on college students, particularly on their academic performance, general health and engagement in hazardous behaviors [1-3]. Repetitive drinking behaviors facilitate the development of motivational, rewarding features of alcohol-related stimuli [4], known as the *cue-reactivity paradigm*. This paradigm posits that exposure to substance-related cues induces changes in psychophysiological reactivity [5], behavioral approaches [6], emotional and cognitive responses [7] and self-reported cravings [8]. It has been hypothesized that craving for alcohol, defined as an impetuous desire to drink, is one of the underlying mechanisms in the maintenance of drinking-related behaviors [9]. Previous studies confirm that alcohol-related stimuli trigger greater urges to drink than neutral stimuli [1, 10, 11]. Hence, there is a greater likelihood of developing dependence over the years, due to the widespread availability of alcohol-related cues.

A growing body of literature on Virtual Reality (VR) has recently drawn attention, due to its applicability in the field of psychology. VR adds realism and a sense of presence to existing methods such as image/video or *in-vivo* cue exposure, by creating an immersive environment in which individuals can experience different scenarios in a similar way to real-life situations [12].VR techniques involve a dynamic human-computer interaction [13], which enhances the ecological validity of traditional paradigms. Several studies have demonstrated the effectiveness of VR as an instrument to trigger cravings in individuals who misuse alcohol [11, 14] and reduce the urge to drink in individuals with Alcohol Use Disorder (AUD) [15,16].

Similarly, a previous study [3] showed that binge drinking college students reported greater levels of alcohol craving following VR exposure to environments containing alcohol-related stimuli. Alcohol use and misuse in college is a serious worldwide concern with neuro-psycho-social implications for students [17]. Hence, there is an urgent need to conduct studies and implement new technologies that could help to detect problematic alcohol-related behaviors. In turn, this could lead to the development of further prevention methods, and a reduction in harmful behaviors among students.

The aim of this study was to explore empirically how well behavioral and self-reported measures of craving and anxiety differentiated between light and heavy drinking college students when exposed to a VR alcohol-related cue environment.

2. Method

2.1. Participants

Twenty-five college students (M = 25.48, SD = 9.29), 5 men and 20 women, participated in this study after their informed consent. On the basis of their alcohol consumption, participants were divided into two groups: light and heavy drinking college students. The cut-off score was ≤10 standard drink units (SDU/month) for light drinking college student and ≥11 SDU/month for heavy drinking college students. A Spanish SDU is a single consumption of 10g of ethanol corresponding to a standard measure of wine or beer and half a measure of liquors [18].

Light drinking college students (N = 13, AUDIT M = 2.84, SD = 3.46) consumed on average M = 2.92, SD = 2.53 SDU/month. Heavy drinking college students (N = 12, AUDIT M = 7.25, SD = 4.22) consumed on average M = 23.5, SD = 9.84 SDU/month.

Four participants reported a family AUD history. Exclusion criteria were participants with current psychopathology, severe vision problems, epilepsy or participants taking benzodiazepine medication.

2.2. Instruments

- *Alcohol Use Disorder Identification Test (AUDIT*) [19]. The Spanish version of AUDIT [20] is a 10-item scale that aims to explore alcohol use problems and risk consumption. Responses to each item are scored from 0 to 4 and the maximum score is 40.
- *Visual Analog Scale – Anxiety (VAS-A).*The VAS-A was a self-reported scale designed to assess anxiety levels from 0 to 10 when participants were exposed to a beverage, where 0 was "no anxiety" and 10 was "intense anxiety".
- *Visual Analog Scale – Craving (VAS-C).*The VAS-C was a self-reported scale designed to assess urges to drink on a scale from 0 to 10 when participants observed their beverages, where 0 was "no urge to drink" and 10 was "intense urge to drink".

2.3. Procedure

College students were recruited to participate in this study after their informed consent. Approval was obtained from the Ethics Committee of the University of Barcelona. Demographic information, psychopathology history, family alcoholism history and monthly and weekly alcohol consumption data were collected. Then, participants were asked to complete the AUDIT questionnaire. Subsequently, they were exposed to the VR environment (*Alco-VR*), which was comprised of four areas: restaurant, bar, bedroom and chill-out area, all of which contained alcohol-related stimuli (e.g. bottles of alcohol on the tables, commercials with alcohol content and glasses of alcohol). Different beverages (beer, wine, vodka, whisky, tequila, rum, gin, champagne, fresh juice, coffee, water and soda) could be chosen from a menu every time the experimenter asked participants to sit down (on a chair, a sofa, a bed or a stool). In each situation (restaurant, chill-out area, bar and bedroom), students were asked to explore the environment first and to choose either an alcoholic or non-alcoholic drink from a menu. Once they had selected a beverage, participants were asked to observe it for 10 seconds and then were asked to report their anxiety and craving levels on VAS-A and VAS-C. Oculus Rift Development Kit 2 and a joystick were used in the exposure protocol.

2.4. Statistical analysis

Repeated measures ANOVA with a Greenhouse-Geisser correction was used to determine whether there were statistically significant differences between light and heavy drinking students in terms of self-reported levels of craving and anxiety during exposure to the four virtual environments. Given the chi-square results, tests were run to explore the relationship between group and type of preferred beverages. A series of Pearson correlations were performed to test the relationships between craving and anxiety levels within the different settings of the VR environment. Data were analyzed using SPSS Statistics Version 23.0.

3. Results

3.1. Self-reported anxiety and craving responses among drinking college students

Neither the main effects nor the interactions were statistically significant. Our data showed no statistically significant differences in self-reported craving across all four settings of the VR environment ($F(2.031, 46.705) = .178$, $p > .05$, $\eta^2 = .05$). There were no statistically significant differences between light and heavy drinkers ($F(1, 23) = .48$, $p > .05$, $\eta^2 = .02$). Finally, there were no statistically significant differences in self-reported craving across all four VR settings between light and heavy drinking students ($F(2.031, 46.705) = 1.942$, $p > .05$, $\eta^2 = .22$).

Similarly, there were no statistically significant differences in self-reported anxiety across all four settings of the VR environment ($F(2.163, 49.744) = .342$, $p > .05$, $\eta^2 = .16$). There were no statistically significant differences between light and heavy drinkers ($F(1, 23) = .027$, $p > .05$, $\eta^2 = .001$). Finally, the results indicated no statistically significant differences in self-reported anxiety levels between light and heavy drinking students across all four VR settings ($F(2.163, 49.744) = 2.416$, $p > .05$, $\eta^2 = .18$).

Table 1.*M* and *SD* of self-reported levels of anxiety and craving in heavy and lightdrinking students

	Restaurant		**Bar**		**Chill-out area**		**Bedroom**	
	Craving	*Anxiety*	*Craving*	*Anxiety*	*Craving*	*Anxiety*	*Craving*	*Anxiety*
Heavy drinkers	*M*= 3.83 *SD*= 2.91	*M*= .83 *SD*= 1.46	*M*= 4.25 *SD*= 3.01	*M*= .58 *SD*= 1.16	*M*= 4.75 *SD*= 3.52	*M*= 1.08 *SD*= 1.73	*M*= 4.58 *SD*= 3.52	*M*= .92 *SD*= 1.73
Light drinkers	*M*= 5.46 *SD*= 3.15	*M*= .54 *SD*= .96	*M*= 5.62 *SD*= 2.29	*M*= 1.23 *SD*= 2.12	*M*= 4.62 *SD*= 3.25	*M*= .62 *SD*= .96	*M*= 4.85 *SD*= 3.18	*M*= .69 *SD*= 1.10

M, mean; *SD*, standard deviation

3.2. Types of preferred beverages among drinking college students

There was a significant difference between the type of beverage preferred by heavy and light drinking college students $\chi^2(1) = 9.64$, $p < .05$ within the VR restaurant setting. As observed in Figure 1, heavy drinking college students opted for alcoholic beverages, whereas light drinking college students preferred non-alcoholic beverages.

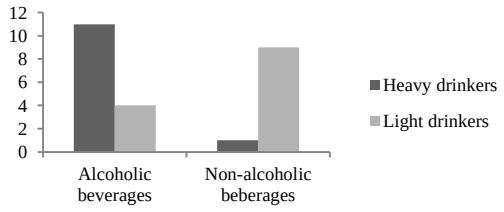

Figure 1. Types of preferred beverages within the VR restaurant environment

Similarly, there was a significant difference between the type of preferred alcoholic/non-alcoholic beverages of heavy and light drinking college students $\chi^2(1) =$

7.67, $p < .05$ within the bar setting. However, no significant associations between group and type of preferred beverages were found for the chill-out area $\chi^2(1) = .99$, $p = .32$ and the bedroom setting $\chi^2(1) = .32$, $p = .56$.

3.3. Relationship between craving and anxiety levels within VR environments

There was a significant relationship in the cravings reported on the VAS-C by light drinkers across all four VR settings (between restaurant setting and bar, $r = .89$, $p < .001$; restaurant and chill-out area, $r = .84$, $p < .001$; restaurant and bedroom, $r = .65$, $p < .05$; bar and bedroom, $r = .56$, $p < .05$; bar and chill-out area, $r = .61$, $p < .05$; bedroom and chill-out area, $r = .65$, $p < .05$). There was a significant relationship in cravings reported on the VAS-C by heavy drinkers across all four VR settings (between restaurant setting and bar, $r = .94$, $p < .001$; restaurant and chill-out area, $r = .84$, $p = .001$; restaurant and bedroom, $r = .63$, $p < .05$; bar and bedroom, $r = .71$, $p < .05$; bar and chill-out area, $r = .90$, $p < .001$; bedroom and chill-out area, $r = .93$, $p < .001$). Similarly, there was a significant relationship in anxiety reported on the VAS-A by light drinkers across all four VR settings (between restaurant and bar, $r = .86$, $p < .001$; restaurant and chill-out area, $r = .87$, $p < .001$; restaurant and bedroom, $r = .71$, $p < .05$; bar and chill-out area, $r = .66$, $p < .05$; bar and bedroom, $r = .77$, $p < .05$; bedroom and chill-out area, $r = .66$, $p < .05$). There was a significant relationship in anxiety reported on the VAS-A by heavy drinkers across all four VR settings (between restaurant and bar, $r = .96$, $p < .001$; restaurant and chill-out area, $r = .86$, $p < .001$; restaurant and bedroom, $r = .81$, $p = .001$; bar and chill-out area, $r = .74$, $p < .05$; bar and bedroom, $r = .75$, $p < .05$; bedroom and chill-out area, $r = .61$, $p < .05$).

4. Conclusions

The aim of this study was to determine which measures can best differentiate between light and heavy drinking college students using a four-setting VR environment.

The results of the study show a preference for alcoholic beverages in heavy drinking college students. Light drinking students were more likely to opt for non-alcoholic drinks within VR restaurant and bar settings. However, no statistical differences were found between light and heavy drinking college students in their scores on craving and anxiety self-reports. Hence, our data indicate that behavioral measures are more suitable for identifying differences between light and heavy drinkers than self-reported measures of craving and anxiety. It seems more effective to detect heavy drinking cases in college students through behavioral parameters such as choosing between alcoholic and non-alcoholic cues (beverages), rather than explicitly reporting craving and anxiety levels on a scale, as students may try to minimize their consumption behavior.

A key limitation of this study is the small sample. A larger sample may have revealed significant differences between heavy and light drinking cases. Nevertheless, future studies are necessary to determine whether measures of craving and anxiety, such as eye tracking or psychophysiological responses, perform better than self-reports in differentiating between heavy and light drinking cases.

Acknowledgments. This study was supported by the Spanish Ministry of “Sanidad, Servicios Sociales e Igualdad. Delegación del Gobierno para el Plan Nacional sobre

Drogas" (FEDER/UE/Project 2016I078: 'ALCO-VR. Protocolo basado en realidad virtual para el tratamiento de pacientes con trastorno por uso de alcohol severo').

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